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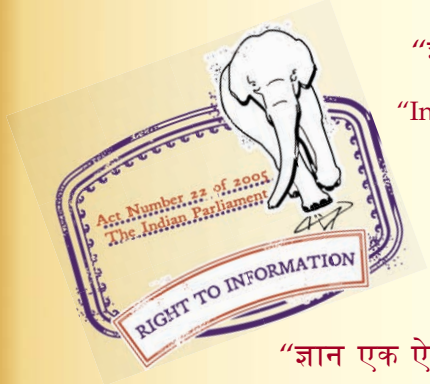

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"Knowledge is such a treasure which cannot be stolen"

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IS : 10698 - 1983
(Reaffirmed 2005)

Indian Standard

METHOD FOR DETERMINATION OF THERMAL DIFFUSIVITY OF FOODGRAINS

UDC 633·1 : 536·41

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 2

December 1983

Indian Standard

METHOD FOR DETERMINATION OF THERMAL DIFFUSIVITY OF FOODGRAINS

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METHOD FOR DETERMINATION OF THERMAL DIFFUSIVITY OF FOODGRAINS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 7 November 1983, after the draft finalized by the Storage Structures and Storage Management Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 In order to calculate the temperature change in a grain bin due to fluctuations in external or internal temperature and to predict the heat transfer in the foodgrains, it is essential to determine thermal diffusivity of foodgrains.

0.3 Because of different methods used by agricultural scientists for its determination it is not possible to have reproducible and repeatable values of this characteristic. This standard, therefore, prescribes a standard method for determining the thermal diffusivity of foodgrains. Adoption of this standard would enable the compilation of reliable data from all research workers on a uniform basis.

0.4 For the guidance of the design engineers, some of the determined values of thermal diffusivity are given in Appendix A.

0.5 In the preparation of this standard, considerable assistance has been drawn from the work carried at the Department of Processing and Agricultural Structures, College of Agricultural Engineering, Punjab Agricultural University, Ludhiana.

0.6 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard prescribes a method for determination of thermal diffusivity of foodgrains.

*Rules for rounding off numerical values (*revised*).

2. APPARATUS

2.1 The apparatus with the following assembly shall be used for determination of the thermal diffusivity of different foodgrains (*see* Fig. 1).

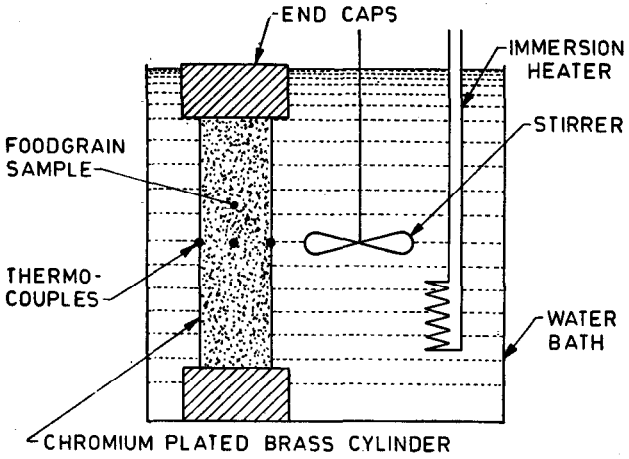

FIG. 1 DETAILS OF THERMAL DIFFUSIVITY APPARATUS

2.1.1 The apparatus consists of a thermal diffusivity tube and an insulated and well-stirred water bath of 25 litre capacity.

2.1.1.1 The thermal diffusivity tube comprises a cylindrical container of 5·4 cm diameter and 23 cm height; and two end caps. The cylindrical container should be chromium-plated brass; while the end caps should be of such sheets as to act as an insulator and withstand temperature of hot water.

2.1.1.2 Two copper constantan thermocouples should be soldered to the outer surface of the tube to monitor the temperature of the sample at the surface of the tube. The average of the two readings may be taken to determine the surface temperature. Another thermocouple should be placed along the axis of the tube to record the temperature at the centre of the tube.

3. TEST SAMPLE

3.1 The foodgrain sample shall be properly cleaned so that it does not have refractions [*see* IS : 4333 (Part 1)-1977*] of more than 0·5 percent. It should be free from insect, pests and micro-organisms.

3.2 The foodgrain shall be of the same variety.

*Method of analysis of foodgrains : Part 1 Refractions (*first revision*).

3.3 The moisture content of the foodgrain shall be measured in accordance with the procedure laid down in IS : 4333 (Part 2) - 1967* and stated in the test report.

4. PROCEDURE

4.1 Fill the cylinder with the foodgrain and place the entire assembly with end caps and thermocouples in a water bath (*see* Fig. 1). Heat the water bath at constant rate with the help of 1 000 watt immersion heater. The output of the heater may be noted by connecting a wattmeter in the circuit. Stir the water in the tank with the help of a stirrer at suitable speed, driven by sewing machine motor (universal type) of rating 40 W (1/20 HP), 4 000 rpm and coupled to speed regulator.

5. CALCULATION

5.1 Plot the temperature versus time curve for the centre and the surface of the tube and calculate the thermal diffusivity by using the following formula:

$$\alpha = \frac{R^2 A}{4 (T_R - T_C)}$$

where

α = thermal diffusivity in cm/²sec;

R = radius of the tube in cm;

A = constant slope of temperature versus time curve in °C/sec; and

$T_R - T_C$ = constant temperature difference at any time between temperature at the surface (T_R) and temperature at the centre (T_C) of thermal diffusivity tube in °C (*see* Fig. 2).

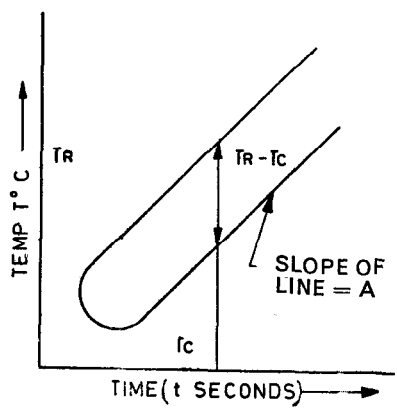

FIG. 2 TIME TEMPERATURE CURVE

*Method of analysis of foodgrains : Part 2 Moisture.

5.2 Repeat the experiment at different levels of moisture content of the sample and note the results.

6. TEST REPORT

6.1 The test report should indicate all the characteristics of the grain (*see* **3.1** and **3.3**) and whether the grain has been graded or not before undertaking the measurement of thermal diffusivity.

APPENDIX A

(*Clause* 0.4)

VALUES OF THERMAL DIFFUSIVITY OF DIFFERENT FOODGRAINS

A-1. REGRESSION EQUATIONS FOR THERMAL DIFFUSIVITY

A-1.1 The regression equations for some of the varieties of wheat, maize and paddy are as follows :

Sl No.	*Crop*	*Variety*	*Thermal Diffusivity Equation*
i)	Wheat	Wg-357	$\alpha = 0{\cdot}001\ 011\ 32 - 0{\cdot}000\ 008\ M$
		Kalyan 227	$\alpha = 0{\cdot}001\ 099\ 2 - 0{\cdot}000\ 008\ M$
		S-308	$\alpha = 0{\cdot}001\ 074\ 9 - 0{\cdot}000\ 010\ 4\ M$
ii)	Maize	Vijay	$\alpha = 0{\cdot}001\ 064\ 9 - 0{\cdot}000\ 006\ 146\ M$
		Local	$\alpha = 0{\cdot}001\ 167\ 55 - 0{\cdot}000\ 005\ 107\ M$
iii)	Paddy	IR-8	$\alpha = 0{\cdot}001\ 755 - 0{\cdot}000\ 025\ M$
		Jaya	$\alpha = 0{\cdot}001\ 582\ 6 - 0{\cdot}000\ 021\ 93\ M$
		Jhona 349	$\alpha = 0{\cdot}001\ 703\ 27 - 0{\cdot}000\ 021\ 98\ M$
		Palman 579	$\alpha = 0{\cdot}001\ 630\ 3 - 0{\cdot}000\ 021\ 85\ M$

where

α = thermal diffusivity in cm^2/s; and

M = moisture content on wet basis, percent.

A-2. THERMAL DIFFUSIVITY VALUES

A-2.1 Some values of thermal diffusivity of jowar and groundnut at different levels of moisture are given below:

Sl No.	*Moisture Content Percent*	*Thermal Diffusivity in cm²/s*			
		Jowar		*Groundnut*	
		PSH-2 Variety	*Swarna* Variety	*AK-12-24* Variety	*SB-11* Variety
i)	8	0·001 169	0·001 105	0·000 724	0·000 942 8
ii)	11	0·000 349 4	0·000 867	0·000 681 9	0·000 693 1
iii)	14	0·000 775 7	0·000 783 8	0·000 634 2	0·000 651 5
iv)	17	0·000 727 3	0·000 771 3	0·000 609 8	0·000 640 4
v)	20	0·000 734 0	0·000 749 8	0·000 628 1	0·000 640)

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2